10/579275

IAP9 Rec'd PCT/PTO 12 MAY 2006

SUBSTITUTE SPECIFICATION: CLEAN COPY

10/579275
IAP9 Rec'd PCT/PTO 12 MAY 2006

~~Pc 10813~~

METHOD FOR IMPROVING A CRUISE CONTROL SYSTEM

[0001] The present invention relates to a method for improving a cruise control system.

[0002] Following assist systems which are employed more and more frequently in vehicles, active speed control systems, i.e. cruise control systems, also known as ACC (Adaptive Cruise Control), AICC (Adaptive Intelligent Cruise Control) or ICC (Intelligent Cruise Control), will gain in significance on the market because they can greatly relieve the driver in operating the vehicle. In making the driver's life easier, they can enhance driving comfort significantly. However, the consequence is that particularly high demands are placed on these systems in terms of control comfort.

[0003] Previous brake control functions, such as anti-lock system (ABS), driving dynamics control (ESP), or traction slip control (TCS), etc., place especially high demands on the reaction rate of hydraulics and electronics because the control quality of these systems depends thereon.

[0004] Therefore, up-to-date brake systems which are usually equipped with an electronic brake control system including ABS, TCS or ESP exhibit a 'quick' system reaction to a brake pressure requirement. This implies that after a defined brake pressure requirement, the hydraulic and electronic components of the brake system will react to this requirement in a short time in order to adjust the desired brake pressure as quickly as possible.

[0005] An object of the invention involves enhancing the comfort and safety of a cruise control system.

SUMMARY OF THE INVENTION

[0006] This object is achieved by a method for operating a cruise control system of a vehicle. In the method a system reaction of an electronic brake control system of the vehicle to a brake pressure requirement of the cruise control system occurs at a relatively slow rate.

[0007] In the following, all known cruise control systems or speed control systems including cruise control functions will be referred to as 'adaptive cruise control' systems or briefly 'ACC'. Hence, all feasible cruise control systems such as ACC, AICC or ICC, but also all subordinate speed control systems, such as CC, are among these systems in the sense of the invention.

[0008] The object at issue is achieved in that a system reaction of an electronic brake control system of the vehicle to a brake pressure requirement of the cruise control system occurs at a relatively slow rate.

[0009] More specifically, it is arranged for that the brake system shall not react with a maximum or a very high reaction rate when the ACC system is active. The reason underlying is because it has shown that normally a relatively early detection of an object by the ACC system is possible and that the control operations may then take place accordingly 'slowly'.

[0010] In addition, improvements of the radar system or infrared sensor system of the ACC systems allow still further increasing

the ranges and, thus, extending the reaction times. The comfort of the control may hence be further enhanced.

[0011] It is arranged for by the invention that the system reaction occurs more slowly than in the event of a brake pressure requirement from the electronic brake control system.

[0012] It is provided by the invention that the system reaction to a brake pressure requirement of the cruise control system takes place so slowly that any resulting maximum pressure increase or pressure decrease rate is not exceeded.

[0013] It is arranged for by the invention that the resulting maximum pressure increase or pressure decrease rate is in a range of 5 bar/s to 20 bar/s.

[0014] The object is also achieved in that following a brake pressure requirement of the cruise control system is the planning of brake control in advance for a long term, preferably for the period of an entire brake operation.

[0015] It is provided according to the invention that when planning the brake control in advance, a resulting brake pressure is not adjusted with each program run of a program of the electronic brake control system.

[0016] In up-to-date electronic brake control systems, times of a program run (loop times) of roughly 10 ms have proven necessary. According to the invention, a resulting brake pressure is adjusted in a monitoring time of 10 to 10000, preferably in a monitoring time of 100 to 1000, program runs in the event of brake pressure requirements of the ACC system.

[0017] According to the invention, an average brake pressure (brake pressure integral) is determined when planning brake control, and a resulting brake pressure is adjusted according to the brake pressure integral.

[0018] Accordingly, system reactions of an electronic brake control system of the vehicle to a brake pressure, brake torque or deceleration requirement of the cruise control or speed control system, in particular ACC system, do not occur 'in time', i.e. instantaneously. Instead, the requirement is 'distributed' in the form of a brake pressure integral to situation-responsive predetermined time intervals.

[0019] It is arranged for by the invention that the average brake pressure is determined for a period of 1 sec to 5 sec.

[0020] It is provided by the invention that the time is variably adjusted according to a magnitude or a rise gradient of the brake pressure requirement of the cruise control system.

[0021] The invention is also achieved by a method for improving a cruise control system which is characterized in that a function module of the cruise control system calculates a deceleration and/or torque requirement which is put into practice by a pressure controller of the electronic brake control unit, that in the event that the cruise control system detects an object which demands an adaptation of speed, a corresponding deceleration or a deceleration torque being required to adjust a minimum distance is calculated, and that the corresponding deceleration or the deceleration torque is adjusted in conformity with a comfortable control.

[0022] The invention will now be explained in detail by way of an embodiment.

[0023] A vehicle includes an ACC system and an electronic brake control system (EBS unit).

[0024] An ACC function module of the ACC system calculates a deceleration and/or torque requirement which is put into practice by the corresponding pressure controller of the ABS unit. When the ACC system detects an object requiring an adaptation of speed, a corresponding deceleration (torque) is calculated which is required to adjust the distance. This deceleration (torque) is not adjusted as quickly as possible but in a maximum comfortable manner.

[0025] First the engine torque of the driving motor of the vehicle is reduced in order to adjust the desired deceleration of the vehicle. If the corresponding deceleration (torque) is not achieved by the reduction of the engine torque, active brake pressure build-up is required in addition.

[0026] A comparison between nominal values and actual values is performed to determine an appropriate brake pressure. As this occurs, a deviation is calculated for the required brake pressure and the brake pressure or wheel brake pressure measured or reproduced by a model in each loop (program run of the EBS program), i.e. in a determined time. This deviation is taken into account as an indicator of the control of the actuator system for pressure buildup in the wheel brakes.

[0027] The nominal values of the brake pressure are determined preferably from filtered deceleration specifications (torques) of

the ACC function module. The specifications change slowly and likewise change the pressure requirements.

[0028] The method of the invention does not change the requirements in relatively short time intervals, but plans the adjustment of brake pressure over a long period, preferably, for an entire brake operation. In this arrangement, it is assumed that the ACC specifications change only at a slow rate.

[0029] If it is necessary to perform an adjustment of brake pressure beyond the engine torque control, a brake pressure integral which is necessary to adjust the desired deceleration (torque) is calculated on the basis of preferably 1 to 5 seconds (sec).

[0030] According to the invention, each change of the ACC specification is hence not converted with respect to a momentary change of the brake pressure requirement, but a brake pressure requirement is predetermined for a long period of time.

[0031] More specifically, braking is planned.

[0032] The method of the invention harmonizes the brake pressure requirements and, thus, also enhances the comfort of brake control.

[0033] The time basis of the brake integral is changed preferably in dependence on the magnitude or the rise gradient of the ACC specification. Very high specifications and/or high rise gradients reduce the time basis in order to permit a sufficiently quick system reaction if e.g. a detected driving situation has to be avoided. This enhances the comfort of the system.

BRIEF DESCRIPTION OF THE DRAWINGS

[0034] The invention will be explained more closely by way of an example making reference to three illustrations (Figure 1 to Figure 3).

[0035] Figure 1 shows vehicle accelerations a plotted against time t.

[0036] Figure 2 shows how pressures P_{old} in the brake system are plotted without planning brake control in advance as a function of time t according to the invention.

[0037] Figure 3 shows how pressures P_{old} in the brake system are plotted with a planning of brake control in advance as a function of time t according to the invention.

DETAILED DESCRIPTION OF THE DRAWINGS

[0038] Figure 1 illustrates a nominal acceleration $a_{nominal}$ which results from the requirement of an ACC, for example. In brake control, the result of this requirement without planning is a vehicle acceleration with several 'overshooters' I, II, II corresponding to the curve $a_{actual,\ old}$. The control according to the invention results in a vehicle acceleration corresponding to the curve $a_{actual,\ new}$ with only one 'overshooter' IV; thereafter the actual acceleration $a_{actual,\ new}$ will slowly approach the desired nominal acceleration. The control comfort of the system is improved in this fashion.

[0039] Figure 2 shows how pressures P_{old} in the brake system are plotted without planning brake control in advance as disclosed in the invention. Based on the specification of the nominal

acceleration $a_{nominal}$, a nominal pressure $P_{nominal, old}$ is produced in the brake system, which shows the 'overshooters' corresponding to the vehicle acceleration $a_{actual, old}$.

[0040] In addition, the adjustment of the nominal pressure $P_{nominal}$ can lead to a resulting actual pressure $P_{actual, old, control}$ which shows additional vibrations induced by the pressure control of the vehicle brakes. Control of the vehicle acceleration a will be even more deteriorated due to these pressure fluctuations. Driving comfort is further impaired.

[0041] When pressures P_{new} in the brake system are plotted with a planning of brake control in advance as a function of time t according to Figure 3, according to the nominal pressure $P_{nominal, new}$, the result is an actual pressure $P_{actual, new}$ which basically does not show any overshooters but allows a good adaptation of the former pressure level P_1 to the new pressure level P_2. From this results the adjustment of the vehicle acceleration shown in Figure 1, i.e. more specifically, a relatively uniform vehicle deceleration without significant abrupt changes.